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Executive summaray

It is well known that the responses to a large number of stress situation vary a great deal among individuals. The majority of the studies on the subject is primarly concerned with the influence of personality traits on mental strees and are often related to clinical disorders. On the other hand relatively few results were reported relating personality to cardiovascular, endocrine and autonomic nervous system responses to strees. The present investigation is concerned with this interaction. The first part of this study is concerned with the specific and non-specific responses to following stressing situations : A: cold exposure at 10°C for 90 minutes, B: heat exposure at 40°C for 90 minutes, C: hand in water at 4°C for 3 minutes, and D: face exposure to wind at 4°C. During these tests the following measurements were made: skin temperatures, rectal temperature, heart rate, plasma noradrenaline and adrenaline, plasma and urinary cortisol and individual rating of the stress immediately following the tests. The second part of this study concerns the Big-Five questionnaire which was used to establish the personality traits of the subjects. Overall this project was aimed at comparing the physiological responses to different stressses and to relate these to the personality traits of the subjets.

The report for this contract is the object of the five enclosed manuscript.

Study on individual responses to cold

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This study was done for the Defense Research and Development Canada-Toronto,

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Abstract

LeBlanc J. and Ducharme. M.B. Study on individual responses to cold.

Numerous studies have reported large variations in individual responses to stress, including exposure to cold. An experiment was planned to measure specific and non-specific responses as well as subjective ratings in order to try to define the factors involved in the control of responses to cold. To that effect a group of 20 subjects were exposed to cold at 10°C for 90 minutes. Rectal and skin temperatures were recorded throughout the experimet, while diuresis, urinary catecholamines and subjective rating of the test were measured at the end of the cold exposure. The role of subcutaneous fat was confirmed as being a prominent individual factor in the diminution of shivering due to heat loss reduction. To explain the reduced shivering in the presence of higher fat insulation, it is suggested that this may be due to a reduced cold receptor stimulation resulting from lower skin temperature. Heavier subjects, independent of body fat or of level of physical training, were shown to be more resistant to cold possibly because of a diminution of body surface in relation to body weight. Relevant to these findings it was found that the subjects with the lower skin temperatures at the end of the experiment, were those who rated the cold exposure as causing the less discomfort and in whom the cold diuresis and the total urinary excretion of adrenaline were the lowest.

Study on individual responses to cold.

Introduction

Many studies have reported great individual variations in responses to exposure to a large number of stress situations. This was particularly the case for various groups of subjects exposed to low environmental temperatures (1,2). For instance many groups of primitive people such as the aborigines of central Australia (3), the bushmen of the Kalahari desert (4) and the Alacaluf Indians of Tierra del Fuego (5), who experience different exposure to cold depending on the season, all show the same responses when exposed to overnight low temperatures. They failed to respond to cold; they did not shiver and their rectal and skin temperatures continued to fall throughout the night. In spite of that, when compared to a group of white subjects who progressively increased their levels of shivering, they were able to sleep all night. The Eskimos, who live in the Northern Territories, behave quite differently. They respond to cold by shivering and by keeping a warm skin temperature exactly like white subjects (6). It was suggested that this lack of adaptation be due to the fact that Eskimos, because of their appropriate clothing and shelter, rarely shiver even at very low environmental temperatures. However the face and the extremities are much more often exposed to the discomfort of cold. Because of that they have developed a local adaptation to cold. Immersion of one hand in ice cold water is very well supported by them while white subjects experienced great 5

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autonomic nervous system (7). Gaspé fisherman in the time when they use to fish in the traditional manner, responded exactly like the Eskimos to the cold hand test (7,8,9). In non-adapted individuals those with a higher percentage of subcutaneous fat, have been shown not to respond to cold, exactly like the primitive populations described above (10,11,12). These findings suggest further investigation on this manner and aim at finding if the level of physical training and if body weight could have some influence on the individual responses to cold. An experiment was planned to measure specific and non-specific responses as well as subjective ratings in order to try to define the factors involved in the control of responses to cold. To that effect a group of 20 young adults were exposed to cold at 10°C for 90 minutes while skin and rectal temperatures were continuously monitored, and catecholamines were determined in the urine. The subjects were also asked to rate the discomfort caused by cold exposure.

Protocole

Twenty young adults, 11 men and 9 women, ranging in age between 25 and 35 years participated in this study. They all signed a consent form which had been accepted by the university experimental ethic guidelines. All experiments took place at 13:00hr following a light meal taken at 11:30h. The test started at 13:00h. Wearing shorts and a tee shirt, they sat for 30 minutes in a metabolic chamber at 26°C while skin temperatures on forehead, chest, belly, back, thigh and leg as well rectal temperature were continuously recorded with thermistors. The formula described by Snellen(13) was used to calculate the average Ts when the subjects were exposed to cold. The Ts of the chest, forehead, abdomen and back were each multiply by 8.5 to give a total of 34. By multiplying this value by 1.5 we arrive at 51% which represents the portion of these parts of the body to total Ts. In addition Ts of the thigh is multiplied by 38 and that of the leg by 11. The addition

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of these values gives the average Ts. The rectal probe (10cm) was obtained from Baxter Healthcare,Valencia CA (400 series). Body mass index (BMI) was measured by dividing the body weight (kg) by the the square of height (m) (14). The percentage of body fat was estimated by measuring with a caliper (John Bull co, London) the skinfold of various parts of the body (biceps, triceps, subscapular and suprailliac) according to the method described by Jackson and Pollock (15). A continuous flow of air was passed through a specially designed metabolic chamber having a 1.016 m3 volume in which the subject sat during the experiment, while the O2 consumed and the CO2 produced were continuously recorded (16). At 13:30h the subjets moved to an adjacant room kept at 10°C where they remained for 1.5 hour while the same measurements were made as during the control period. Immediately following the experiment the sujects rated the severity of the test on a scale ranging from 0 to 10 where 0 would indicate the absence of pain, while 5 and 10 rated the test as moderately to extremely painfull respectively. The subjects voided before entering the cold room and the urine was collected at the end of the exposure. The results give the volume of urine during that period. Acidified samples were kept at –70°C for further determination of catecholamines by liquid chromatography (17) and cortisone by radioimmunoassay .

Results.

The characteristics of the subjects are reported on table 1. The table shows that all the characteristics measured are within the normal range in this group of young adults. In effect the highest BMI found among the subjects was 26.5, indicating that none could be considered as being overweight (18).. Figure 1 shows that the subjects with the highesr VO2 max. had the lowest % of body fat .

Table 1. Characteristics of the subjects with means ± s. e.

VO2(max)	% Fat	Age	BMI	Weight (kg)
41.2	20.6	25.9	23.4	68.8
±1.7	±1.6	±0.9	±0.6	±3.4

The responses to cold exposure which are reported on figure 2, show large differences in oxygen consumption among the subjets. Figure 3 shows a gradual increase with time, in the average oxygen consumption response, reaching a somewhat stable peak between 70 and 90 minutes. The results for temperature measurements are reported on figure 4. A significant correlation (P0,01) is observed between time of exposure and Tr which reach a peak also between 70 to 90 minutes. As expected the Ts values show a gradual decline to reach a stable plateau during the second part of the exposure Figure 5 indicates negative significant correlations between the % of body fat and both rectal and pectoral skin temperatures after 80 minutes at 10°C. a negative correlation as also found between time of exposure and Tr 9 figre 6). Figure 7 shows that a large % of fat caused a reduction of the O2 consumption, as well as the volume of urine collected during the cold exposure. There was no correlation between body weight and % of fat, but as shown on figure 8, the increase in O2 consumed in the cold was significantly smaller in subjects with larger bodyweight even if the results for O2 are expressed as ml/kg/min. As indicated by the standard errors of figure 9, there was a relatively large variation among the subjects for noradrenaline and adrenaline content of the urine during both the control and the cold exposure periods. However a pair t test between these periods indicates that they are significantly different. Figure 10 shows that the subjective rating of cold was significantly positively related to the average Ts as well as to the adrenaline urinary excretion at the end of the cold expoure.

Discussion

The results shown on figure 2 confirm the large variations in individual responses to cold reported by other studies. (1,2,9). Viewing the various significant correlations that were established, it is possible to relate these variations to some characteristics of the subjects. Prior to this instigation, it seems appropriate to visualize the average responses to cold in relation to time (figure 3). As heat production increases, the Ts shows a gradual decline, while Tr remains at the pre-exposure level during the first 60 minutes but increases towards the end of the exposure. At that time, these three variables stabilize to reach a plateau between 60 and 90 min. Sufficient evidence was obtained to propose the % of body fat as a primary factor in the control of these specific responses to systemic cold air exposure. The reduced increase in oxygen consumption observed in subjects with higher percentage of fat, can be partly explained by a parallel significant greater fall in Ts. This finding confirms results of other investigators(10,11,12). The greater fall in Tr found with higher % of fat, would indicate that the heat production in this case is unsufficient at least for the duration of the present investigation. These findings indicate an economy of energy due to increse % of body fat but also suggest, because of the fall in Tr, that the subjects with more subcutaneous fat might become more hypothermic during more prolonged exposure to cold. This is a possibility that would remain to be investigated. At this point, the following question may be asked. "Why is it that fat people with lower Ts are able to maintain their metabolic rate lower than lean individuals in the cold?". The work of Hensel(20) gives a possible explanation to this ambiguous situation. He has shown that the peak response of stimulated cold sensitive neurons is situated at Ts around 26-28°C. At lower skin temperature, which is the case in fat people, the stimulation of cold receptors being reduced this would result

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in reduced shivering in the cold. Relevant to this proposition, the results of the present investigation indicate that at lower Ts, which is observed in fat people, the cold discomfort rating was lower than at higher Ts. It is also shown on figures 2 and 3, in accord with Hensel findings , that at Ts 28C the heat production and the Tr start to increase to reach a plateau after 60 mintes at a time when the average Ts is stable at 26 C. These results confirm that the thermoregulatory responses to cold depend on skin sensory stimulation at Ts varying between 26 and 28 C. The analysis reported on table 2 confirms this proposition. Indeed for mean Ts values of 23.8 for subjects with % of fat higher than 20, the stimulation of cold receptors would be reduced and this would result in reduced oxygen consumption. This would not be the case for subjects with lower % of fat in whom the mean Ts is 26.8.

Table 2. Comparaison of oxygen consumption (ml/subject/min) and Ts values corresponding to % fat above 20, with those below 20, during the last minute of exposure to 10ºC for 90 minutes. Values are means ± s.e.

	% fat above 20	% fat below 20	P values
Ts values	23.7 ± 0.5	26.8 ± 1.1	0.005
O2 values	231.6 ± 15.5	322.1 ± 22.1	0.01

Responses other than those concerned with thermoregulation are also observed. In that respect it was found that cold diuresis is also reduced in fat subjects. This finding is unexplained but it may be suggested that it is related to a reduced cold sensory stimulation when the % of subcutaneous fat is high.

Besides the importance of % body fat in the control of the responses to cold, other factors were also shown to be involved. Subjets with greater body weight had a lower

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response to cold which was independent of the % of body fat. This finding is possibly explained by the fact that less heat is dissipated when the ratio of body surface to body weight is reduced as it is the case in heavier subjets. An increase in urinary excretion of noradrenaline and adrenaline was also found. It was not possible to establish a correlation between these results and the % of body fat possibly because of the large individual variations of these measurements. However a positive correlation was found between urinary adrenaline and the rating of cold.

In all the reduced heat loss in the cold, due to increased subcutaneous fat, was found to be less costly in terms of energy requirements and subjectively more acceptable. As an explaination for this reduced increase in O2 consumption observed in fat people it is suggested that it may be due to a reduced cold receptor stimulation resulting from lower Ts. It was also found that subjets with larger body weight, independent of body fat, or with higher energy expenditure capacity were more resistant to cold. The present investigation, being limited to a 90 minute exposure, it would be interesting, in practical terms, to see if the same findings would be obtained in subjets exposed to cold for longer periods of time.

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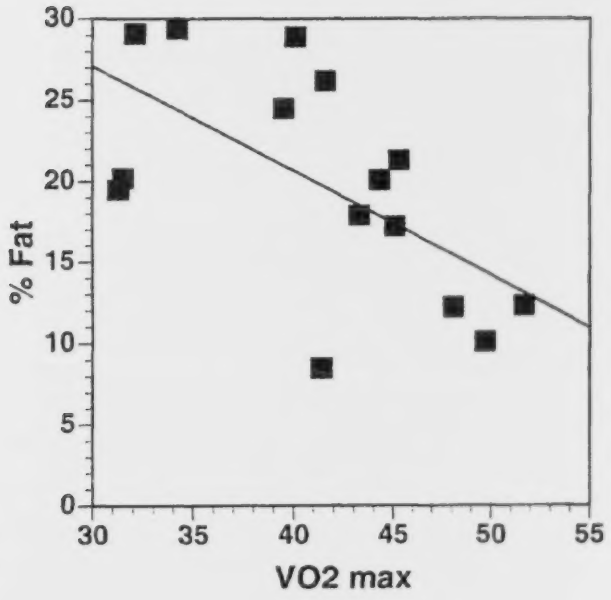

Figure 1. Correlation between the % of fat the VO2 max.(P 0.01).

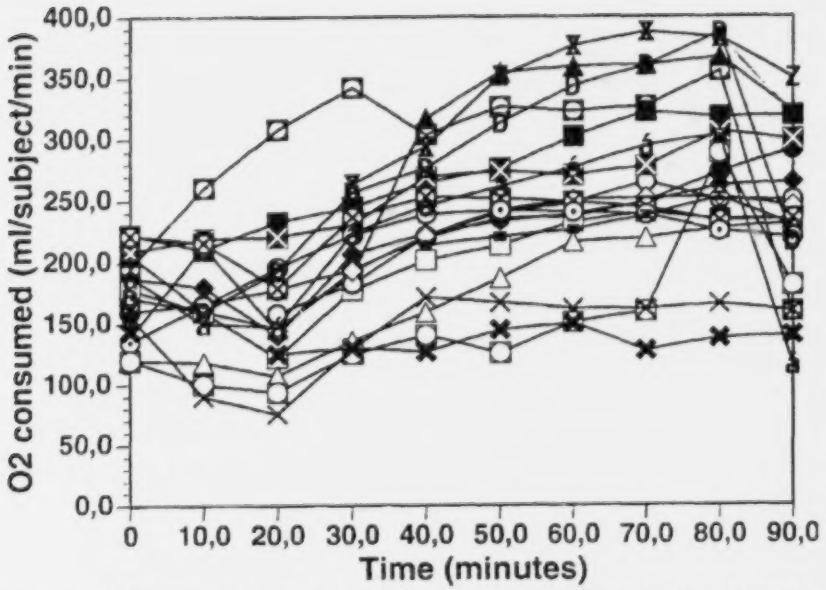

Figure 2. Individual variations in O2 consumed during the 90 minutes cold exposure at 10ºC.

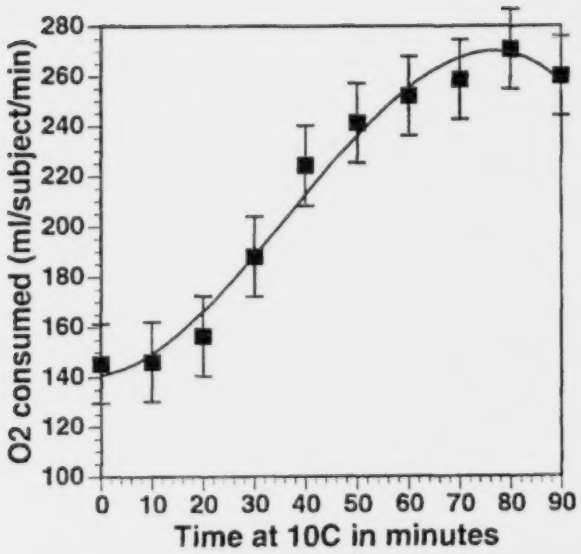

Figure 3. Average for all subjects of O2 consumed during cold exposure at 10ºC.

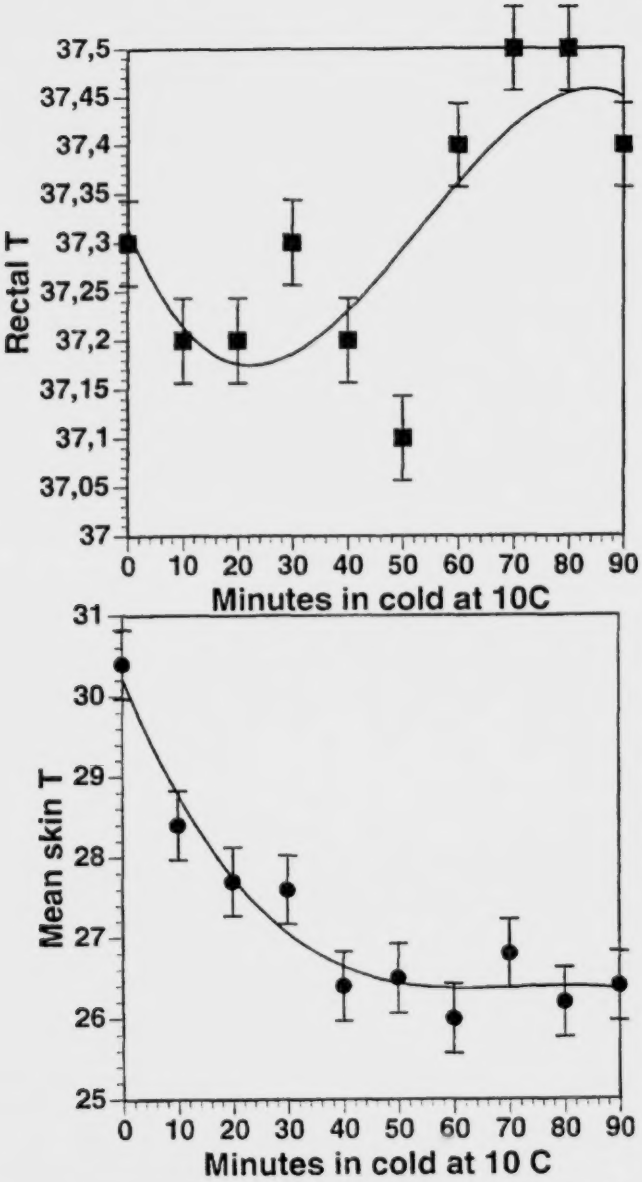

Figure 4. The average variations of. Tr and Ts during the 90 minute exposure at 10°C.

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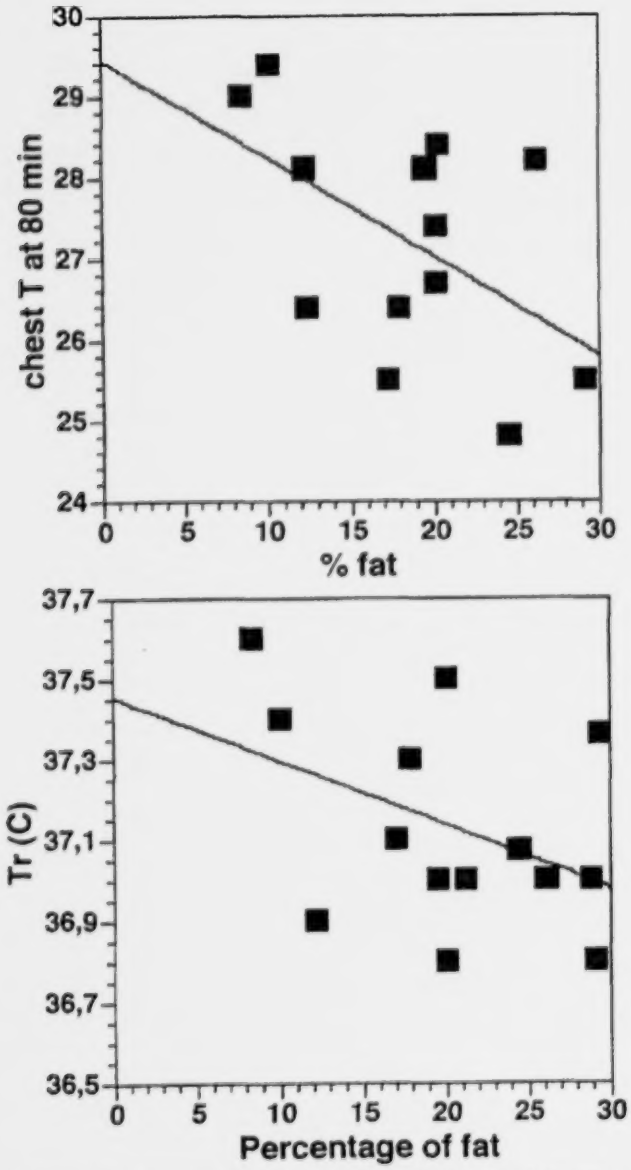

Figure 5. Correlation between the % of fat and the Ts (P 0.01) and Tr (P 0.01) at the end of the 90 minute exposure at 10°C.

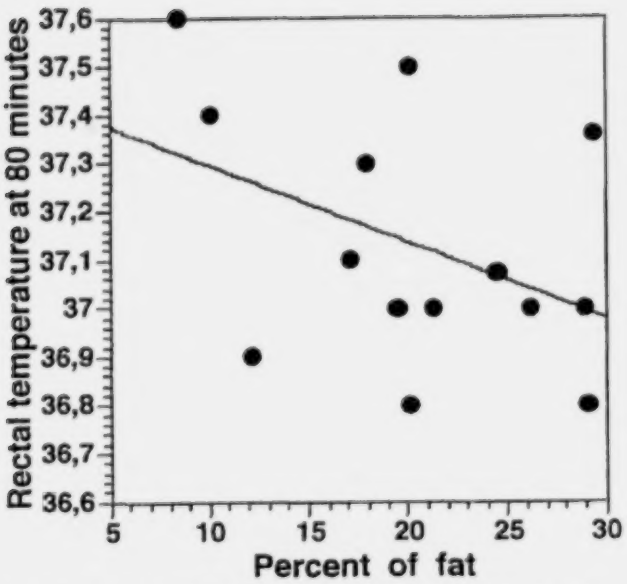

Figure 6. correlation between percent of fat and Tr after 80 minutes exposure at 10°C. P=0,04.

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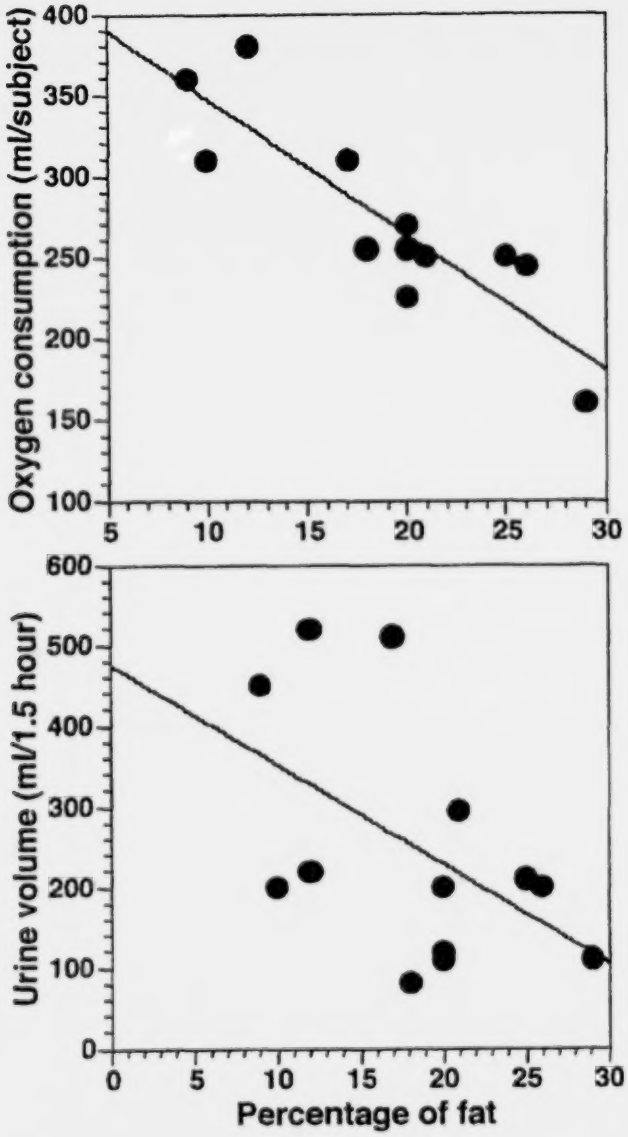

Figure 7. Correlation between the percentage of fat and the oxygen consumption (P<0,01) and urine volume(P=0,01) at the end of cold exposure at 10°C.

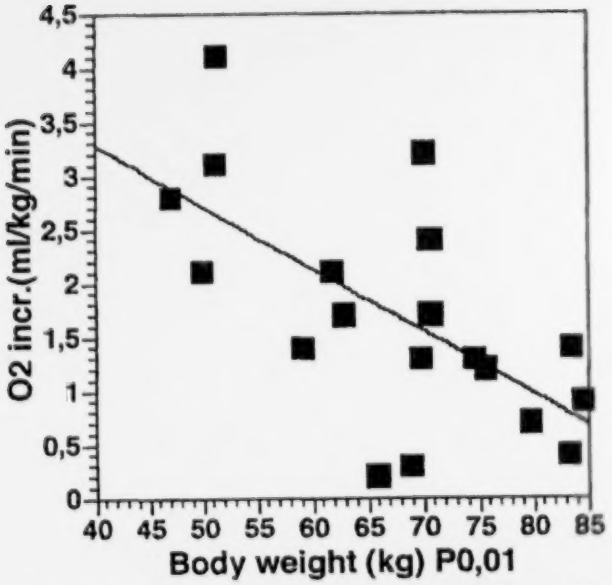

Figure 8. The correlation between body weight and the O2 consumption increase during the cold exposure (P= 0.01).

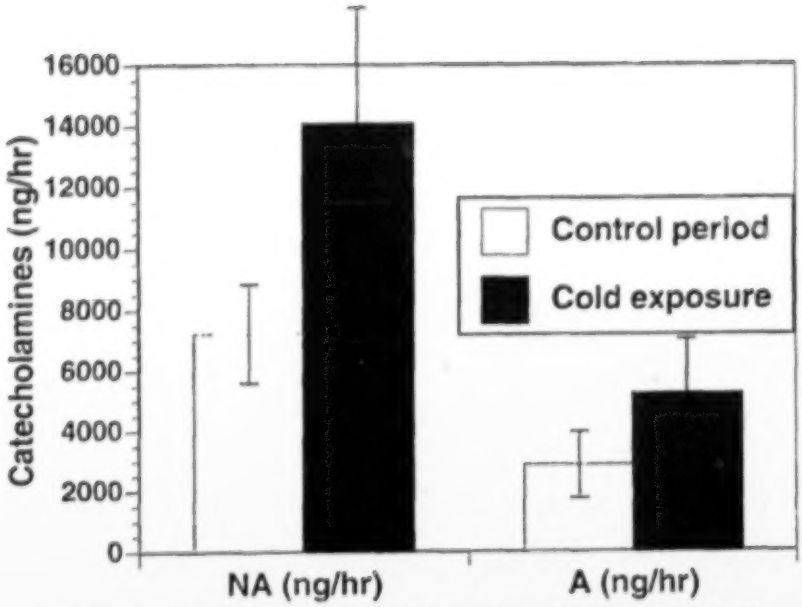

Figure 9. Urinary excretion of noradrenaline (NA) and of adrenaline (A) during control period at 26º and during cold exposure at 10ºC. For NA, P=0,02 and for A, P=0,5.

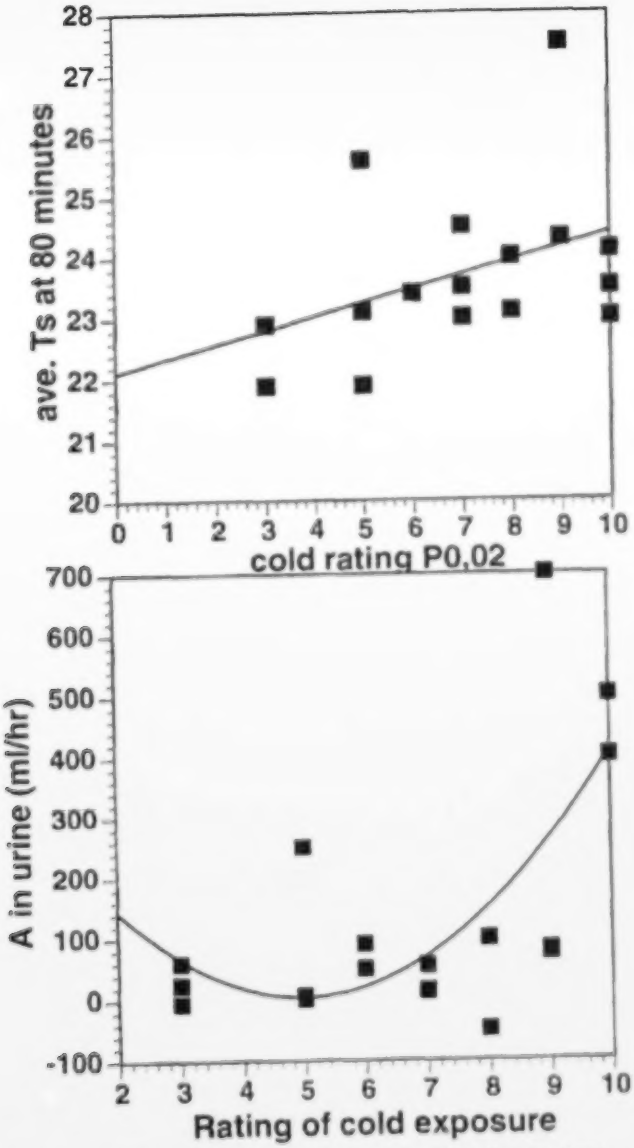

Figure 10. correlations between cold discomfort rating and the increase in adrenaline (P=0,010) and of TS(P=0,01).

Exposure to cold and personality traits

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Short title: Exposure to cold and personality

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Abstract

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Exposure to cold and personality traits. PHYSIO BEHAV 56( )ooo-ooo, 2002.- We often hear people expressing individual different tolerance to heat or to cold. The present investigation aimed at finding if personality trait had an influence on the response to cold. To that effect a group of 20 young adults were exposed to cold at 10° C for 90 minutes while oxygen consumption and skin and rectal temperatures were continuously monitored. The subjects were also asked to rate the discomfort caused by cold exposure. The big-five inventory test was used to measure the personality trait of the subjects. A better tolerance to cold was found in subjects with neuroticism prevalence, Indeed a reduced increase in oxygen consumption, a greater fall in mean skin temperature and a diminished rating of discomfort were observed in this group of subjects. These findings are somewhat unexpected since neuroticism is often associated with greater arousal in the presence of a stress. As an explanation it is suggested that cold caused a greater arousal of the sympathetic nervous system and this resulted in a greater fall in Ts. This fall in Ts caused a reduced O2 consumption and a reduced discomfort in the cold.

Cold exposure Personality trait Neuroticism Stress arousal

Exposure to cold and personality traits

Introduction

Individual responses to environmental stresses, such as exposure to high and low temperatures or to high altitude have been the object of numerous studies. With regard to exposure to cold, evidence of adaptation has been found in many primitive groups such as the Australian Aborigines, Kalahari Bushmen, Alacaluf Indians and Eskimos (1,2,3,4). This was also verified among groups of white populations(5,6). These investigations described many physiological and hormonal beneficial alterations to explain the mechanism of adaptation to cold. In spite of that, studies on the possible role of individual personality have not been reported. We often hear people expressing individual tolerance or intolerance to cold. The present investigation aimed at finding if personality trait had an influence on the response to cold. To that effect a group of 20 young adults were exposed to cold at 10° C for 90 minutes while oxygen consumption and skin and rectal temperatures were continuously monitored. The subjects were also asked to rate the discomfort caused by cold exposure. The big-five inventory test was used to measure the personality trait of the subjects (7).

Protocole

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Twenty young adults, 11 male and 9 female, ranging in age from 25 to 35 years participated in this study. They were either technicians or graduate students and their body weight, relative to their height, was within normal range. They all signed a consent form, which had been accepted by the university experimental ethic guidelines. Wearing shorts and tee shirt, the subjects remained in a room at 10°C for 90 minutes while chest, back, abdomrn, thigh and leg as well as rectal temperature were continuously monitored. The formula described by Snellen (8) was used to calculate the average skin temperature. A continuous flow of air was passed through a specially designed metabolic chamber having a 1.016 m3 volume in which the subjects sat, while the O2 consumed was continuously recorded as previously described (9). At the end of the experiment, the subjects rated the test using a scale ranging from 0 to 10 on which 0 would indicate the absence of pain, while 5 was moderately and 10 extremely painful. The big-five inventory test was used to measure the personality traits of the subjects (7). The questionnaire for this test gives the level of the following traits: extraversion, agreeableness, conscientiousness, neuroticism and openness. The multiple regression analysis was used to compare the various parameters used in this study. The nonparametric Wilcockson test was used for the results obtained with rating and for the big-five test.

Results

The means and the standard errors of the characteristics of the subjects, which are reported on table1, show a normal distribution for the various measurements. The multiple regression analysis indicated that among the 5 personality traits, only neuroticism was significantly related to measurements of O2 consumed, temperature of the skin and subjective rating of the stress. These results are shown on table 2. Figure 1 shows that the higher the level of neuroticism score, the lower the increase in oxygen consumption in the cold. This negative correlation was also found for the values of average skin temperature at the end of 90-minute cold exposure (figure 2). With regard to the rating of the 27

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discomfort experienced in the cold, the correlation with neuroticism was significantly negative (figure 3). Figure 4 shows that the low score on rating, relates to lower increase in O2 consumption in the cold. This finding was to be expected and it also corroborates the results showing a negative correlation between neuroticism and both O2 measurements and rating of cold exposure.

Discussion

Neuroticism is the only personality trait that relates to the 3 parameters recorded in a group of subjects exposed to cold for 1.5 hour. Indeed the increase in oxygen consumption, the fall in mean skin temperature and the rating of discomfort all correlated negatively with the level of neuroticism. As would be expected the low score for rating reported on figure 4, was shown to relate to reduced O2 increase. The unexpected tolerance to cold associated with neuroticism suggest the following consideration. It has been shown that the level of shivering for a given cold environmental temperature, is in part function of the temperature of the skin. For example people with larger subcutaneous fat have lower skin temperature and shiver less when exposed to cold (10,11,12). Reference to the work of Hensel (13) suggests that this finding be due to a reduced cold receptor response at lower Ts. We then proceeded to an analysis of results, and it was found that there is no correlation between the percentage of fat and neuroticism. Another possibility is that the lower Ts is due to enhanced vasoconstriction caused by greater activity of the sympathetic nervous system. Indeed neurotics, by nature, are more often disturbed and aroused in response to their daily activities (14). It is then suggested that upon exposure to cold greater arousal of the sympathetic nervous system took place, causing an additional drop in Ts in this group of subjects. In a sense these findings suggest that neurotics are more disturbed mentally by the cold exposure but paradoxically, because of that, they are more resistant to this stress.

The results of this study show that, when exposed to cold, subjects with high levels of neuroticism behave the same as 28

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subjects with higher percentage of fat. Both groups are less disturbed by cold probably because of reduced shivering, which in turn could be related to lower Ts. Taken together these findings suggest that the increased resistance to cold observed in neurotics, is related to greater arousal normally associated with this group of subjects. This assertion is based on measurements which are specific to an environmental stress situation, which in this case was exposure to cold. Recently Matthews and Deary (15) after reviewing the literature on stress arousal and personality, stated that " it may be unwise to make individual differences in arousal the central explanatory construct in personality theory". For that reason attempts to generalize, in view of the findings of the present investigation, for other stressing conditions with different specific responses, must be made with great caution.

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Tables for manuscript by LeBlanc and Ducharme

Table 1. Characteristics of the subjects with means and standard errors.

VO2max	% Fat	Age	BMI	Weight (kg)	Height (cm)
41.2	20.6	25.9	23.4	68.	170.8
∓1.7	∓1.6	∓0.9	∓0.6	∓3.4	±2,8

Table 2. Correlation between the increase in oxygen consumption, mean temperature of the skin and the rating of cold (10°C), and the personality of the subjects. The values are P for the level of significance of the regression coefficients. Bold numbers indicate significant correlations.

	Extraversion	Agreeableness	Conscienciousness	Neuroticism	Openness
O2	0,58	0,67	0,07	**0,015**	0,41
Rating	0,07	0,83	0,18	**0,03**	0,17
1 Ts	0,25	0,66	0,17	**0,03**	

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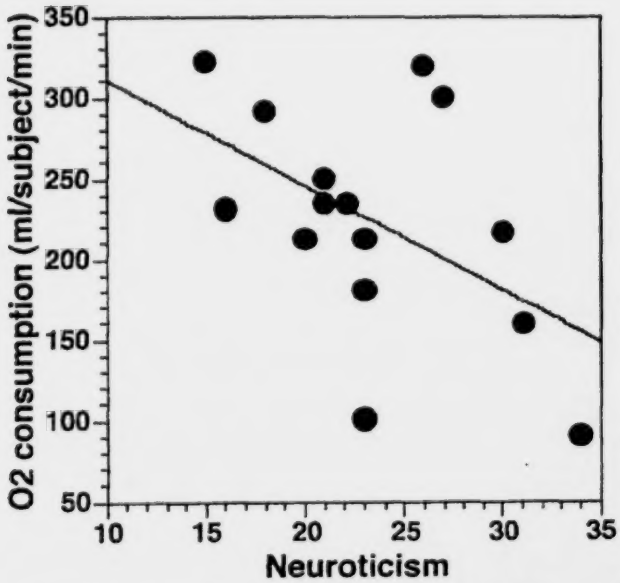

Figure 1. Correlation between neuroticism and O2 consumption at the end of a 90 minute exposure at 10°C (P=0,01).

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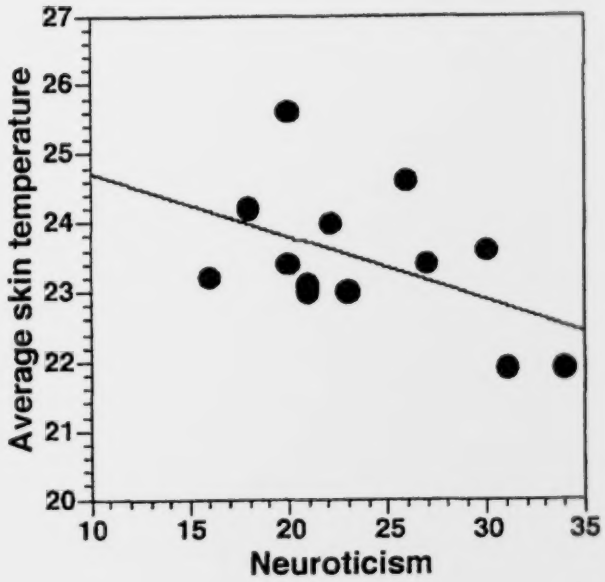

Figure 2. Correlation between average skin temperature in subjects exposed to cold at 10°C for 90 minutes and neuroticism.P=0,03.

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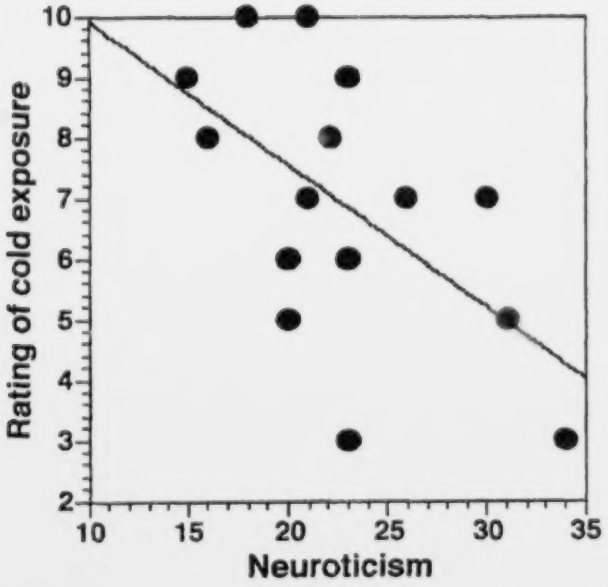

Figure 3. Correlation between rating of cold exposure at 10°C and neuroticism. P=0,03.

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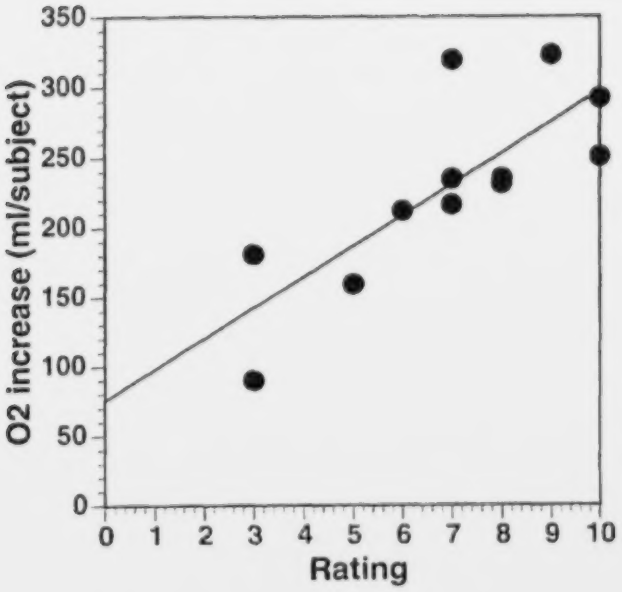

Figure 4. Correlation between rating of cold exposure at 10°C for 90 minutes and the increase in oxygen consumption. P=0,01.

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Exposure to heat and personality

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Introduction

During periods of elevated environmental temperature it is not uncommon to hear some people expressing more discomfort than others. Previous studies have shown marked variations in subjects exposed to low temperatures (Tikusis,1999 ; LeBlanc,1975). The present investigation was aimed at finding individual physiological differences in response to heat. It was also meant to investigate if personality could have some influence on physiological and subjective esponses to elevated temperature. This possibility is suggested by many studies relating personality to various stressing situations. (Walsh,1994 ;Walsh,1994 ; Bhagat,1983 ; McKay and Cooper,1987 ;Newton,1989). For that purpose a group of 20 subjects were kept in a room at 40°C for 1.5 hour while skin and rectal temperature were continously monitored and sweat rate was measured before and after exposure. The subjects were asked to rate the discomfort of the test using a scale calibrated from 0 to 10. They also answered the Big-Five questionnaire in order to assess their personality traits

Protocole

Twenty young adults, 11 men and 9 women, ranging in age between 25 and 35 years participated in this study. They all 38

signed a consent form which had been accepted by the university

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experimental ethic guidelines. All experiments took place at 13:00hr following a light meal taken at 11:30h. Wearing shorts and a tee shirt, they sat for 30 minutes in a metabolic chamber at 26°C while skin temperatures (Ts) on forehead, chest, belly, back, thigh and leg as well as rectal temperature (Tr) were continuously recorded with thermistors. The formula described by Snellen (2000) was used to calculate the average Ts when the subjects were exposed to heat. The Ts of the chest, forehead, abdomen and back were each multiply by 8.5 to give a total of 34. By multiplying this value by 1.5 we arrive at 51% which represents the portion of these parts of the body to total Ts. In addition Ts of the thigh is multiplied by 38 and that of the leg by 11. The addition of these values gives the average Ts. The rectal probe (50cm) was obtained from Baxter Healthcare,Valencia CA (400 series). Sweat rate was measured by weighing the subjects before and after exposure to both 26° C and 40°C. The difference between the two values indicated the water lost due to heat exposure. These measurements were obtained with a scale with a sensitivity equal to ± 10 grams. A continuous flow of air was passed through a specially designed metabolic chamber having a 1.016 m3 volume in which the subject sat during the experiment, while the O2 consumed and the CO2 produced were continuously recorded as previously described (LeBlanc and Cabanac, 1989). At 13:30h the subjets moved to an adjacant room kept at 40°C where they remained for 1.5 hour while the same measurements were made as during the control period. Immediately following the experiment, the subjects rated the discomfort of the test using a scale ranging from 0 to 10 where 0 would indicate the absence of discomfort, while 5 was moderately and 10 extremely painful. The big-five inventory test was used to measure the personality trait of the subjects (Costa and McCrae, 1992). The questionnaire for this test gives the rating of the following traits: extraversion, agreeableness, conscientiousness, neuroticism and openness. The multiple regression analysis was used to compare the rating of the test and the psychological results. The nonparametric Wilcockson test was used for the results obtained with rating and for the big-five test

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Results

As shown on figure 1, the level of Tr did not change throughout the exposure, while all sites of Ts reach a comparable constant temperature of approximately 36°C after 30 minutes. Because of the very small variations of Tr and Ts values, as evidenced by low standard error values, no correlations were found between these variables and the other measured variables such as sweat rate and the rating of discomfort.There was however a significant negative correlation between the rating of the test and the sweat rate as shown on figure 2; the higher the sweating the lower was the rating. It was also found, using the multiple regression analysis, that the rating of the heat test was negatively related to extraversion and positively to neuroticism. (figure 3). Sweat rate and personality were not found to be related when a linear correlation analysis was used. However the utlization of binominal regression revealed a significant bell-shape correlation for the extravertion trait (P<.0,01). With neuroticism the results are completely opposite, showing a reversed bell-shape interaction [P<0,01). For values of sweat rate below 400 ml/hr,the correlation is positive and it is negative for values above 400 (figure 4). With neuroticism the correlation is negative for values below 400 and positive for values above 400 (figure 5). Finally for this group of subjects, the extraversion predominance related negatively with neuroticism as shown on figure 6.

Discussion

Sweat rate has been shown to be significantly related to core temperature (Cabanac and Massonet, 1977) This was not the case in the present study. On the other hand subjective rating and the rate of sweating indicate that there are significant differences in this group of subjects. As expected a lower sweat rate for a given subject was correlated with a subjective greater rating of discomfort. This finding however was not related to differences in body temperature responses as was shown on figure 1. Wheither longer exposures to high environmental temperatures would reveal different responses remains to be investigated.

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Rating of the heat test was related to subject personality. Exposure to 40°C is considered as a light to moderate test by the subjects. The response to this stress was negatively related to extraversion. Predominance of this personality trait predisposes to a more efficient coping with moderate stress intensity (Smith,1983 ; Gold et al,1988). The positive relationship between heat tolerance and neuroticism is somewhat expected for this personality trait. Indeed in this case, in the presence of day to day mental or physical stimulations, the arousal is typically somewhat exaggerated by comparaison with other traits (Eysencj,1967 ; Eysenck,1981).

The rate of sweating is related to both extraversion and neuroticism but in a complex manner. With a linear curve fitting no corelation were found, whereas the binominal approch indicated significant correlations. For neuroticism the correlation is negative for sweat rate up to 400 ml/hr, but positive for higher values, but a completely opposite relationship was found with extraversion. The correlation reported in figure 6 between extraversion and neuroticism may present a partial explanation for these findings. Indeed the predominance for a certain trait correlates with a low incidence for the other trait. For that reason when a subject for example is rated high in neuroticism, his score for extraversion is normaly low. Because of that when the sweat rate is low the neuroticism influence would predominate. The reverse would be expected with extraversion. When the sweat rate is above 400 ml/hr, these relationships were shown to be completely reverse ; the higher the nevrotic trait, the higher the sweat rate. It is proposed that this finding suggests another component in the picture. A possible explanation is that some subjects, those with higher sweat rate, may be more disturbed emotionnaly by the stress, with the result that sweating is produced in excess of thermoregulatory requirements. Indeed sweat is produced not only by heat but also by emotions.

One can only speculate on the fact that sweat rate is reduced with neuroticism in spite of lower rating of tolerance to heat exposure. In other words greater discomfort is associated with lower 41

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defensive responses. It thus seems possible that the greater discomfort of subjects with high neuroticism is simply caused by the absence of sweating. Wheither this defect is related to a central disturbance in the transmition of the signal for sweating or to a lack of activation of the cholinergic nerve fibers of the sweat glands, is a question that deserves further investigation. Walsh et al (1994) reported similar findings for a mental arythmetic test. They suggest that individuals high in neuroticism may have interpretative biases in the sense that they tend to amplify the rating of a stress in spite of a lower response. In their investigation the chalange was a mental test which caused a smaller response in nevrotic subjects, thus giving evidence of an improved defensive response. In the present investigation when dealing with a physical stress, such as exposure to heat, the rating was also amplified and the response reduced. In this case, however, the lower rate of sweating would not prove to be beneficial. These findings suggest that nevrotic individuals have developed a resistance to physiological responses to threatening stimuli of mental or physical origin. As mentioned above it is not evident however that the interpretation of the heat is biased. It is suggested that it may be related instead to the presence of a block in the normal response to heat observed in individuals with this personality trait. Overall this study indicates that the sweat rate, as well as the rating of heat discomfort, are related to personality, but further investigation is needed to understand the mechanism involved and to conclude to a causal relationship .

Acknowledgements.

This study was done under contract with for the Defense Research and Development Canada- Toronto.

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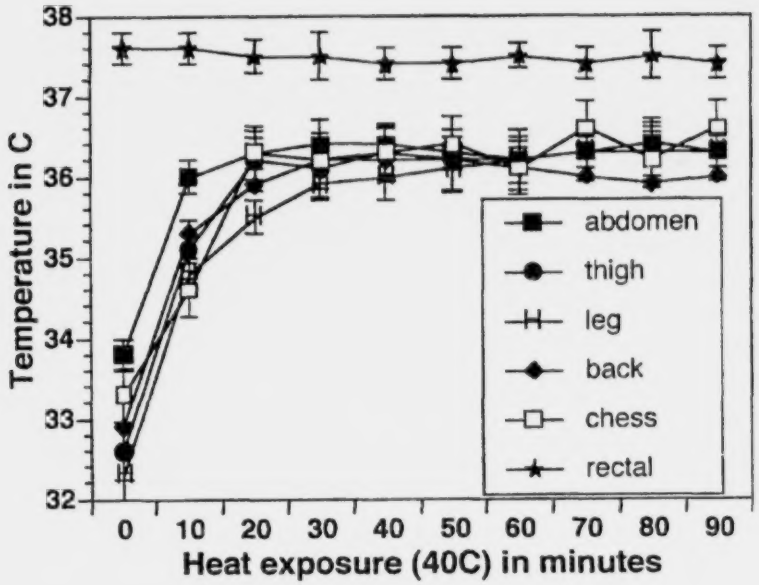

Figure 1. Skin and rectal temperatures during exposure to 40 °C for 90 minutes. Values are means ± standard error.

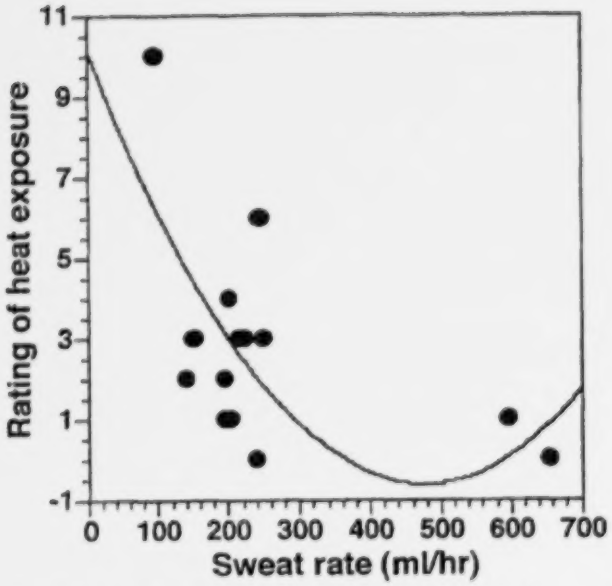

Figure 2. Correlation between sweat secretion and rating during exposure to 40°C. P=0.01.

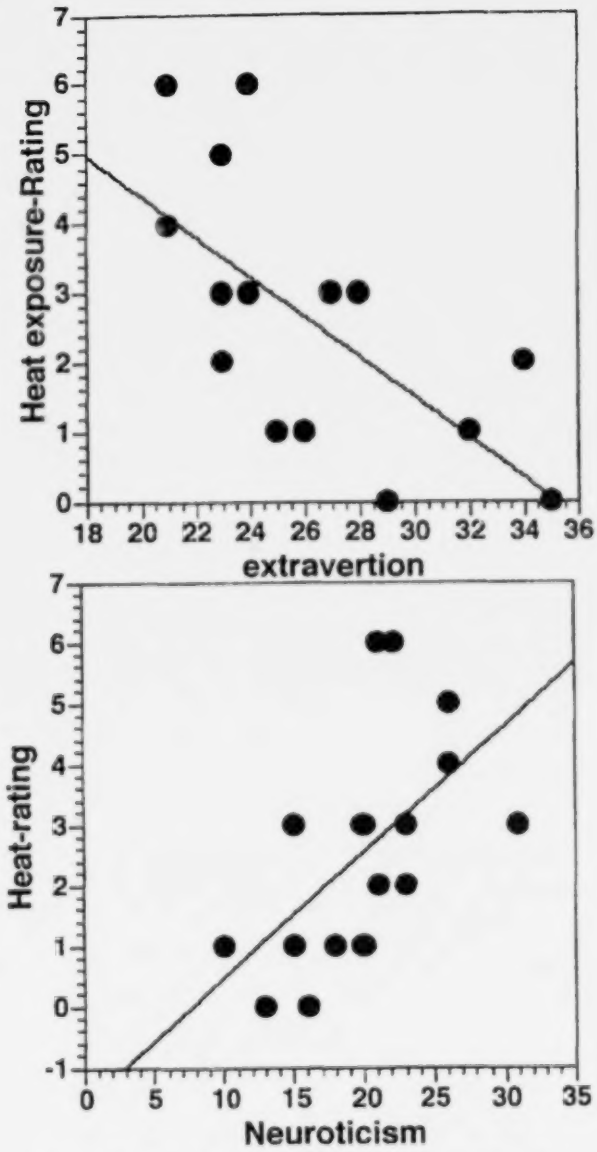

Figure 3. Correlation between extraversion and neuroticism, and rating of discomfort during exposure to 40 exposure. P=0.01 for both correlations

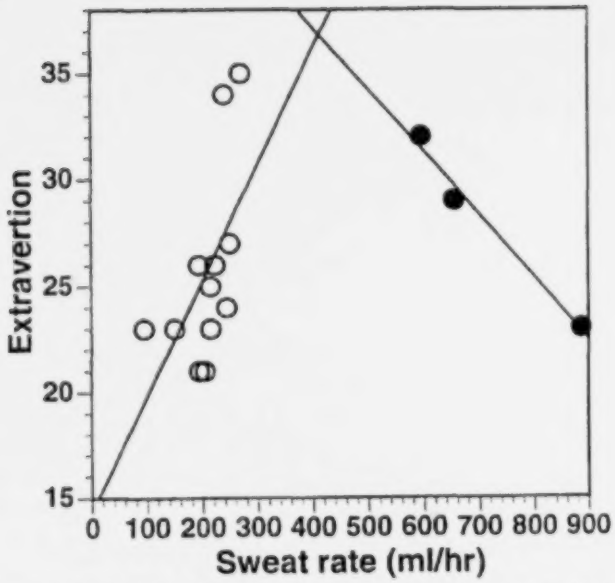

Figure 4. Correlation between sweat rate and extravertion.
For sweat rate below 400, P=0,01, above 400 P<0,01.

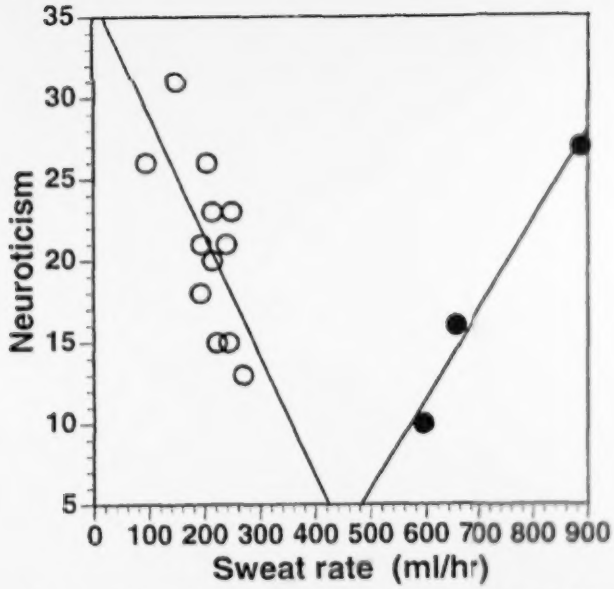

Figure 5. Correltion between sweat rate and neuroticism.
For values below 400 P<0,01 and above P<0,01.

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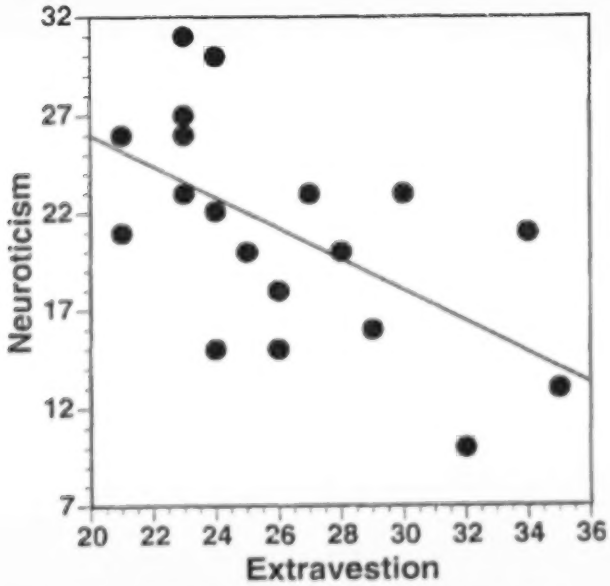

Figure 6. Correlation between extravertion neuroticism traits (P<0,01).

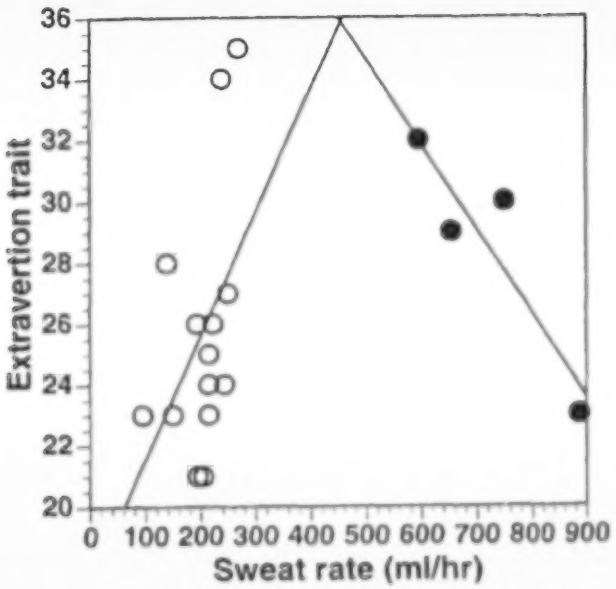

Figure 7 ; Correlation between sweat rate and extravertion. For values of sweat below 400, P=0.01 and for values above 500, P<0,01

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Stress arousal in extraversion and neuroticism

By

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This study was done for the Defencse and Research Development Canada- Toronto,

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Stress arousal in extraversion and neuroticism

Introduction

The literature reports ambiguous findings on the question of interactions between personality and arousal (1). A review of the numerous studies on this subject reveals a complexity of protocols often lacking the common denominators to allow certain consensus. The ambiguity would seem to be related to the use of a large variety of stimulations, as reviewed by Matthews and Deary (2). Mental, emotional and physical tests of various intensity and duration have been used as stimulators, while the responses were obtained from central or autonomic nervous system measurements. On the other hand when stimulations of similar nature were compared, the results indicated some relationship between personality and arousal. This evidence was obtained when physical stress of relatively high intensity was used (3, 4, 5, 6). In line with these findings, the present investigation was designed using a severe physical stress. Indeed blowing cold wind on the face is known to cause great discomfort and pain and a marked elevation of plasma noradrenaline (7, 8) The aim of this study was to compare the personality traits in a group of 20 young adults with their stress evaluation of the cold wind test and the variations of plasma catecholamines.

Protocole

Twenty young adults, 11 male and 9 female, ranging in age from 25 to 35 years participated in this study. They were either technicians or graduate students and their body weight, relative to their height, was within normal range. They all signed a consent form, which had been accepted by the university experimental ethic guidelines. All experiments took place at 13:00hr following a light meal taken at 11:30h. They were all exposed to a **cold face test,** which consisted in blowing air at 4°C and at 60km/hr speed on the face of the subjects for a period of 3 minutes (7,8). Blood samples were drawn at 1, 2 and 3 minutes during the test as well as at 15 minutes before and after the

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test. The HPLC method was used to determine the plasma catecholamine levels (9). Heart rate was continuously monitored during the test. Immediately following experiment, the subjects rated the discomfort of the test using a scale ranging from 0 to 10 where 0 would indicate the absence of pain, while 5 was moderately and 10 extremely painful. The NEO Big-Five Inventory test was used to measure the personality trait of the subjects (10). The questionnaire for this test gives the rating of the following traits: extraversion, agreeableness, conscientiousness, neuroticism and openness. The multiple regression analysis was used to compare the plasma noradrenaline levels and rating, and the psychological results. The nonparametric Wilcockson test was used for the results obtained with rating and for the big-five test

Results

Figure 1 shows that high extraversion significantly relates to low neuroticism. The scoring of the cold wind test, as shown on figure 2, was positively related to extraversion but negatively to neuroticism. The heart rate and noradrenaline values during the test were also positively related to extraversion and negatively to neuroticism as shown on figures 3 and 4. The average noradrenaline value during the test shows a fourfold increase compared to basal values, a finding associated with the severity of the cold wind test.

Discussion

When the NEO Big-Five Inventory was used on this group of twenty subjects, the results indicated that the score for neuroticism is negatively related to extraversion; low extraversion being associated with high neuroticism. This finding is thus the result of subjective evaluation, which must be considered as such. The arousal in this study was a physical stress , which the majority of subjects described as causing great discomfort. This was confirmed by a marked elevation of noradrenaline during the test. It was found that both the rating of the test and the activation of the autonomous nervous system related significantly to extraversion and to neuroticism,

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but in a different manner. The correlations were positive for extraversion and negative with neuroticism. The association with neuroticism was most unexpected. The rating and the hormonal responses were the lowest when the score for neuroticism was the highest. At first glance these findings are unexpected since many studies have reported arousal to be lower in extroversion than in neuroticism. The following possibility, suggested by Eisenck theory (11 12 13), is proposed to explain this paradox. Low to moderate stimulations cause higher arousal in neuroticism, whereas at higher levels the response is greater in extravesion (11, 14).Eisenck argues that neurotics during their day to day activities are more often aroused and for that reason they have developed a certain resistance to extreme stimulation. This protective resistance would be caused by the activation of a central nervous system transmarginal inhibition. In summary it is suggested that the negative relationship observed between neuroticism and the arousal of the autonomic response during the exposure to a severe stress, resemble the mechanism involved in a habituation process. Repeated exposures to low intensity arousal could explain the lower response to more severe stress. The results obtained with extraversion are also unexpected in the sense that stimulation usually results in lower arousal and in diminished responses when dealing with this trait of personality. To discuss this finding it should be kept in mind that the cold wind test to which the subjects were exposed is a rather severe painful test. Extroverted subjects are described as being assertive and to have a disposition for positive control when faced with unexpected situations (15,16). In the present study they could not exert their capacity of opposing the stress which was imposed to them and which they possibly considered as being a hostile situation causing a greater arousal. For that reason it is suggested that their greater response to the cold face test, is a consequence of a distress situation.

In summary it is proposed that the negative relationship observed between neuroticism and the arousal of the autonomic response during exposure to a severe stress, resemble the mechanism involved in a habituation process. Repeated exposures to low intensity arousal resulted in a lower response to more severe stress. In extraverts the same situation is reversed. The lower arousal response normally associated with moderate stimulation is enhanced with more severe stimulation. . Overall the neurotic personality normally associated with exaggerated arousal in the presence of emotional situations (17) sometimes leading to abnormal behavior, proves to be much less affected, in comparison with extraversion, when faced with a more hostile physical environment.

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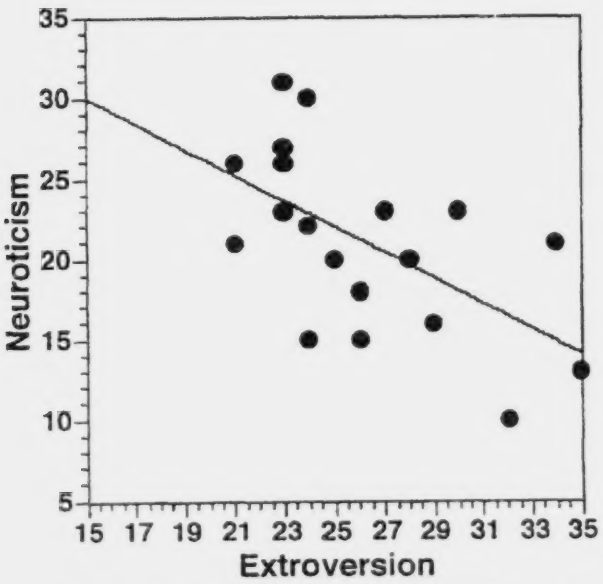

Figure 1. Correlation between extraversion and neuroticism P =0.01.

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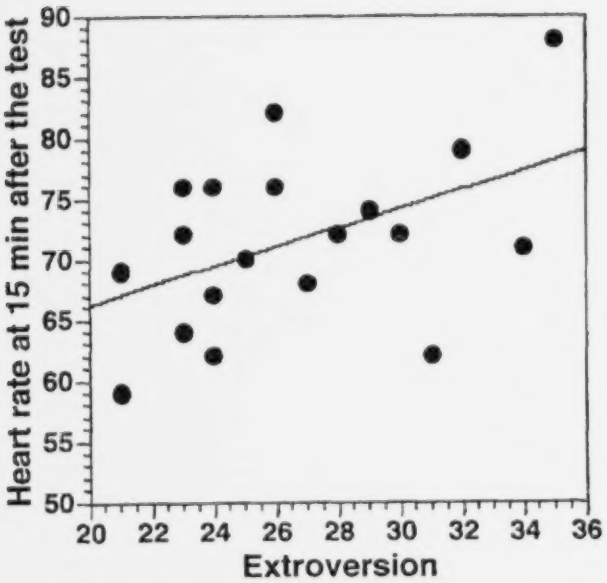

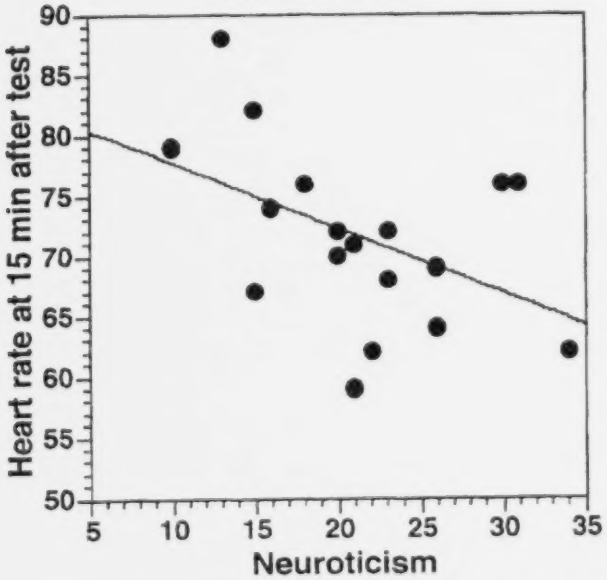

Figure 2. Correlation between neuroticism (P:0.04) and extraversion (P:0.04), and heart rate at different times during the cold face test.

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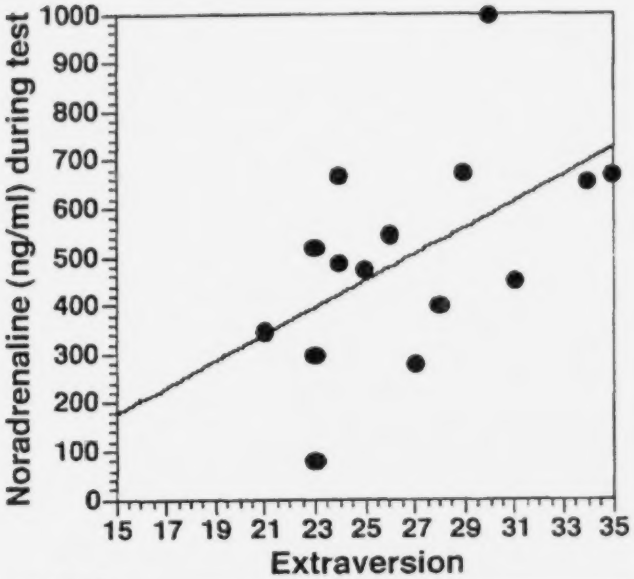

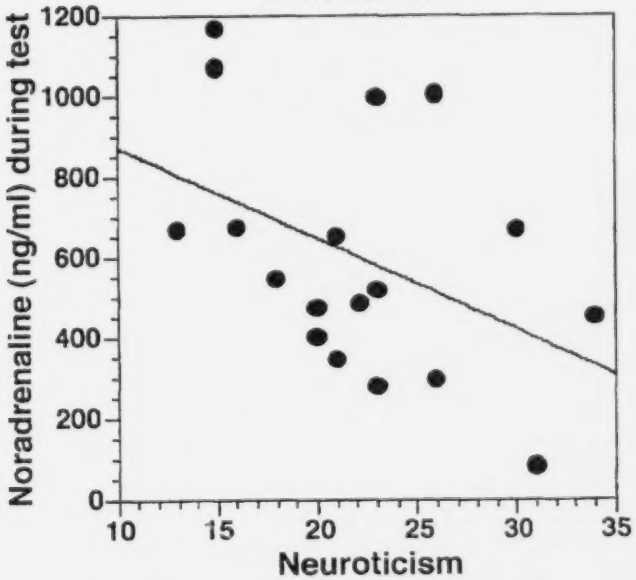

Figure 3 correlation between extraversion and neuriticism, and plasma noradrenaline during the cold face test. P values are 0.01.

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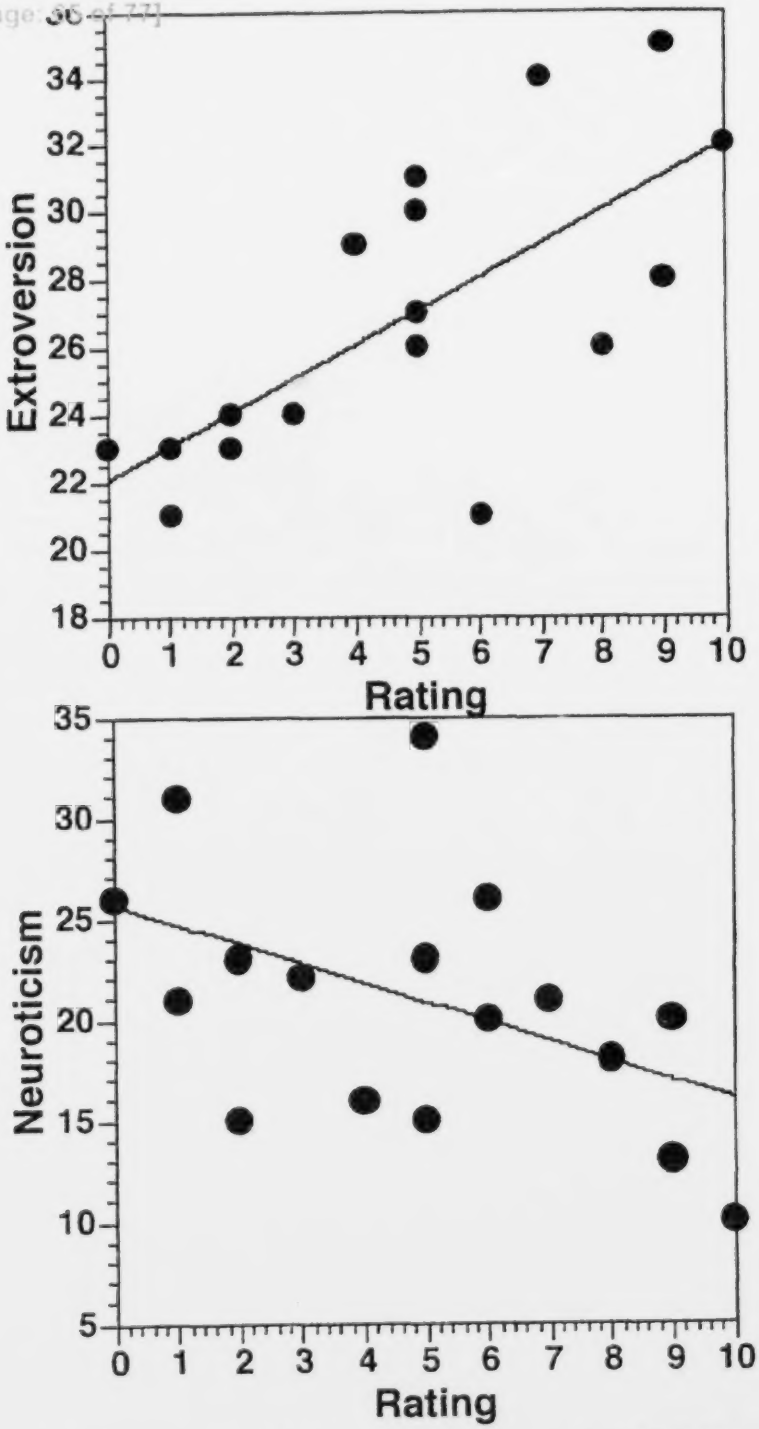

Figure 4. Correlation between extraversion (P;0.01) and neuroticism (P:0.04) and the rating of the cold face test.

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Cortisone, stress and personality

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Introduction

It has long been recognized that stress, especially when of long duration, is associated with activation of the adrenal cortex to produce corticosteroids (1). In such situations the increased cortisol secretion was shown to be associated with endogenous depression (2) and to have many deleterious effects such as impairment of the immunological system efficiency in both laboratory animals and humans (3). Elevated levels of plasma cortisone have also been associated with organic disorders such high blood pleasure (4,5). However the association of plasma cortisone levels with individual personality traits, has not been systematically investigated. The present study was designed to investigate the possible influences of personality traits, as revealed by the big-five questionnaire, on plasma cortisone levels in a group of 20 subjects exposed for 3 minutes to a cold wind blown on the face.

Protocole

Twenty young adults, 11 male and 9 female, ranging in age from 25 to 35 years participated in this study. They were either technicians or graduate students and their body weight, relative to their height, was within normal range. They all signed a consent form, which had been accepted by the university experimental ethic guidelines. All experiments took place at 13:00hr following a light meal taken at 11:30h. They were all exposed to a **cold face test,** which consisted in blowing air at 4°C and at 60 km/hr speed on the face of the subjects for a period of 3 minutes (6). Blood samples were drawn at 1, 2 and 3 minutes during the test as well as at 15 minutes before and after the test. Immediately following each of the experiments, the subjects rated the discomfort of the test using a scale ranging from 0 to 10 where 0 would indicate the absence of pain, while 5 was moderately and 10 extremely painful. The big-five inventory test was used to measure the personality trait of the subjects (7). The questionnaire for this test gives the rating of the following traits: extraversion, agreeableness, conscientiousness, neuroticism and openness. The multiple regression analysis was used to compare the plasma cortisone levels and rating, and the psychological results. The nonparametric Wilcockson test was used for the results obtained with rating and for the big-five test

Results

Figure 1 indicates that there is no significant difference in the plasma cortisone levels before, during and after the exposure of the face to cold wind. The questionnaires for the big-five identified the personality traits of the 20 subjects i.e. extraversion, agreeableness, conscientiousness, neuroticism and openness. The 64

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multiple regression analysis was used to compare these psychological measures with the plasma levels of cortisone determined before (15 minutes), during (3 minutes) and 15 minutes after the cold wind test. The results, reported on figure 2, indicated a significant correlation with extraversion but not with the other traits of personality. Figure 3, which compares the discomfort rating with the plasma cortisol levels, indicates a significant correlation between the two variables. The correlation with rating, reported on figure 4, shows that the predominance of extraversion is related to higher discomfort estimation of the cold test.

Discussion

At 4°C cold air blown on the face at 65 km/hour, is the source of a relatively intense stressful experience, which generates an activation of the sympathetic nervous system (6,8). At the same time the trigeminal nerve is stimulated causing a reflex activation of the efferent vagus nerve (8). The present study has shown that the discomfort rating caused by this stress was positively related to the level of extraversion predominance. This association is usually expected with neuroticism not in extroverted subjects who are described as being assertive and to have a disposition for positive control when faced with unexpected situations (9,10). Two propositions are suggested to explain this paradox. A first possibility concerns the fact that the subjects, in the present study could not exert their capacity of opposing the stress which was imposed to them and which they possibly considered as being a hostile situation causing

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a greater arousal. Another proposition is suggested from the hypothesis proposed by Eysenck (11,12,13). Normally low to moderate levels of stimulation cause higher arousal in intraverts than in extraverts, whereas at higher levels of stimulation a reverse response is observed. (11,14). According to Eysnck theory the arousal in intraverts under high levels of stimulation is reduced, as a protection against over-stimulation, by the activation of a central nervous system transmarginal inhibition, whereas this inhibition would be smaller in extraverts. In summary intraverts being more frequently aroused by minor to moderate stress situations, would develop a state of habituation which would make them less responsive when confronted with more severe stress. The present experiment would support Eysenck theory of arousal in relation to personality.

It was also found that plasma cortisone remained unchanged during, as well as 15 minutes before and after the test. The secretion of cortisol following a stress is caused by an increased release of ACTH (15). For that reason it would seem possible that determinations of cortisol for longer periods could have revealed plasma elevation of the hormone. A significant correlation was observed between the score for extraversion trait and the plasma levels of cortisol during, and 15 minutes before and after the test. In addition, the discomfort rating was positively related to the level of extraversion predominance and at the same time it was found to be positively related to the level of plasma cortisol. Whether there is a causal relationship between higher rating of

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stress discomfort and the elevated levels of cortisone observed in extraverted subjects, cannot be asserted with the present protocol. Similarly further investigation would be required to determine the effect of higher levels of plasma cortisol on health condition of extraverts. It has been shown, relevant to the present discussion, that the levels of cortisol were higher in primary school extroverted students. (16). Put together, these findings indicate that extraverted individuals have higher levels of plasma cortisol, even in basal conditions, and that they report higher degree of discomfit when exposed to stress.

Acknowledgements.
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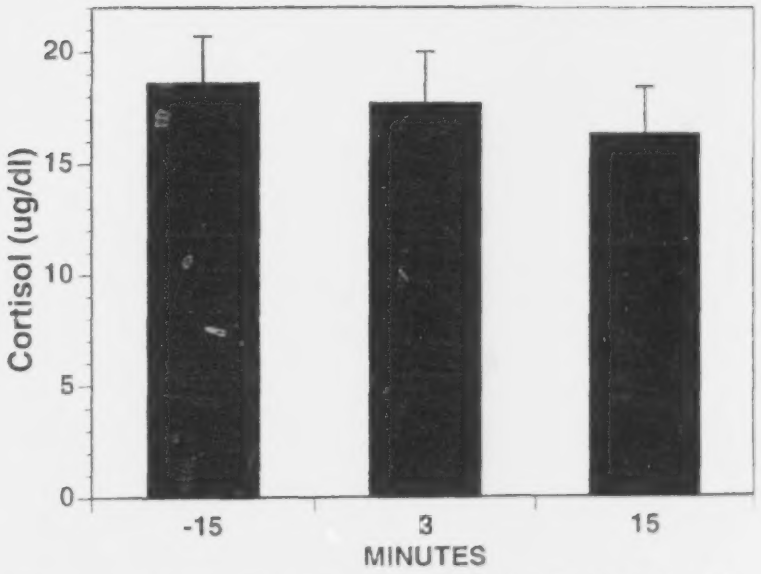

Figure 1. Levels of plasma cortisol at -15, +3 and +15 minutes of the cold wind test. No significant difference between the values.

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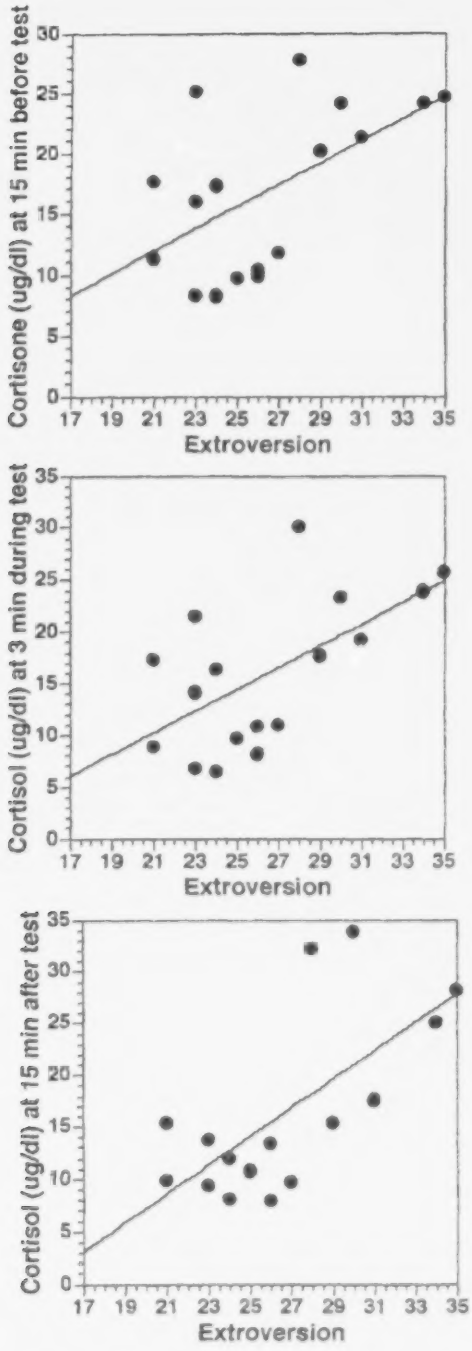
Cortisone (ug/dl) at 15 min before test
Extroversion
Cortisol (ug/dl) at 3 min during test
Extroversion
Cortisol (ug/dl) at 15 min after test
Extroversion

Figure 2.Correlation between plasma cortisol levels during, at 15 minutes before and at 15 minutes after the test, and extraversion. P values in all cases are equal to 0.01

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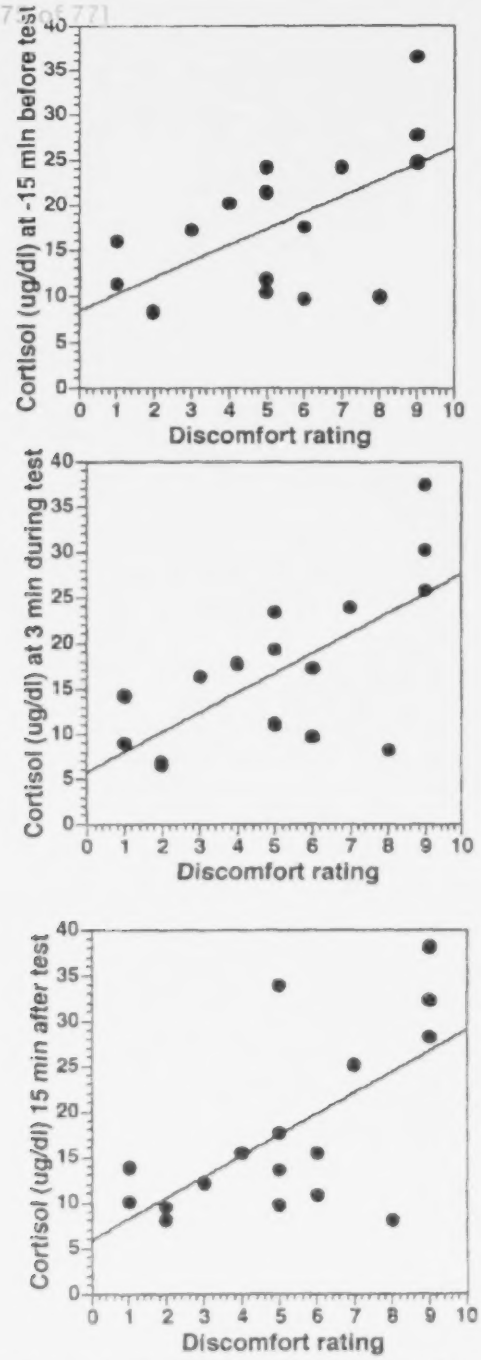
Cortisol (ug/dl) at -15 min before test
Discomfort rating
Cortisol (ug/dl) at 3 min during test
Discomfort rating
Cortisol (ug/dl) 15 min after test
Discomfort rating

Figure 3. Correlation between discomfort rating and levels of plasma cortisol at -15, +3 and +15 minutes of the cold wind test. In all cases the P values are <0.01.

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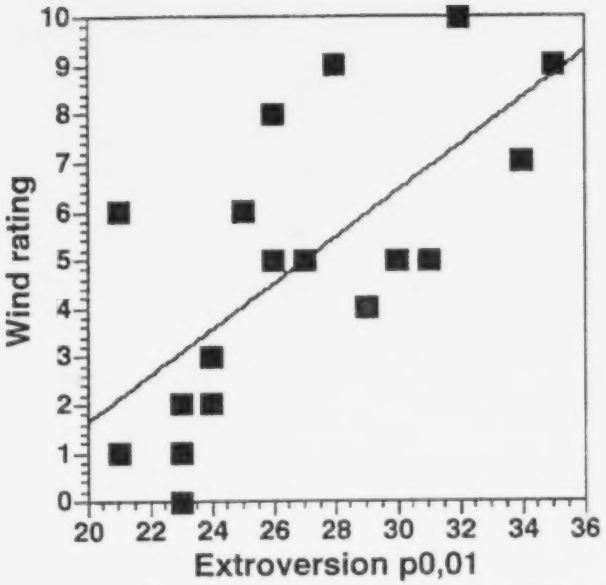

Figure 4. Correlation between extraversion and rating of the cold wind test. P=0.01.